

**Exemption No. 7840**

**UNITED STATES OF AMERICA  
DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION  
RENTON, WASHINGTON 98055-4056**

In the matter of the petition of

**AIRBUS**

for an exemption from § 25.901(c) of Title 14,  
Code of Federal Regulations

**Regulatory Docket No.  
FAA-2002-12142**

**GRANT OF EXEMPTION**

By letter dated April 18, 2002, Mr. Wolfgang Didszuhn, Vice-President Product Integrity, Airbus, 1, Rond-Point Maurice Bellonte, 31700 Blagnac CEDEX, France, petitioned for an exemption from the “no single failure criteria” of § 25.901(c) of Title 14, Code of Federal Regulations (14 CFR) as it relates to “uncontrollable high thrust failure conditions.” Recent studies and service experience indicate that some existing transport category airplanes do not strictly comply with § 25.901(c) for certain uncontrollable high thrust failure conditions. The proposed exemption, if granted, would permit type certification of similarly non-compliant Airbus Model A340-500 and A340-600 airplanes to allow installation of Rolls-Royce Trent 500 series engines.

**The petitioner requires relief from the following regulation(s):**

Section 25.901(c) requires in part that “no single failure will jeopardize the safe operation of the airplane.”

**The petitioner supports its request with the following information:**

“The A340-500 and A340-600 aircraft comply with 25.901(c) for any foreseeable uncontrollable high thrust failure conditions:

- During all phases for the combination of failures,
- Except during final approach phase for the ‘single failure’ criteria.

“The frequency of occurrence of the uncontrollable high thrust failure condition, not complying with FAR 25.901(c) ‘single failure’ criterion is less than one per ten billion aircraft operating hours.

“Airbus has taken all practicable action to minimize the adverse effect on safety associated with granting this petition, in implementing a Thrust Control Malfunction (TCM) logic on the A340-500 and A340-600.

“This logic ensures that compliance with FAR 25.901(c) ‘single failure’ criterion is met for all ground cases.

“However, this logic is not activated in-flight in order to preclude failure cases which could lead to multiple engines shutdown in-flight, and increase the in-flight shutdown rate. For flight phases other than the final approach, the design of the engine hydro-mechanical unit is such that compliance with FAR 25.901(c) ‘single failure’ criterion is met.

“Simulator results obtained during the A340-600 JAA certification session have shown that for a duration of about 12 seconds during approach / landing conditions the ‘no single failure criteria which jeopardize the safe operation of the airplane,’ as required by FAR 25.901(c) is not met.

“Thanks to the TCM logic implemented on the A340-500, and A340-600 models powered by RR Trent 500 engines, the risks associated with exempting the FAR 25.901(c) are much lower than those generally known to exist for similar aircraft within the current transport fleet.

“The proposed thrust management control on the A340-500 and A340-600 is in the public interest.

“This request for exemption is conditional, as the A340-500 and A340-600 will be re-assessed in accordance with the ‘Thrust Control Malfunction (TCM) Airworthiness Program.’ This program is to be instituted by the FAA for the purpose of managing the overall transport aircraft fleet risks associated with this and/or similar potentially unsafe conditions.”

As noted above, the petitioner agrees to demonstrate that:

“...all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from 14CFR 25.901(c) for the A340-500 and -600/RR Trent 500 Series Engines.”

“...the risks associated with granting of the exemption from 14CFR 25.901(c) for the A340-500 and -600/RR Trent 500 Series Engines are low....” Specifically, Airbus will demonstrate the following:

“The A340-500 and -600/RR Trent 500 complies with 14CFR 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and

“The frequency of occurrence of uncontrollable high thrust failure condition on the A340-500 and -600/RR Trent 500 fleet will be less than one per ten billion airplane operating hours.”

#### **Notice and Public Procedure Provided**

A summary of this petition was published in the Federal Register on May 13, 2002 (67 FR 32080). No comments were received.

#### **The Federal Aviation Administration's (FAA) analysis is as follows:**

##### Background

##### Uncontrollable High Thrust Failure Conditions

Numerous single and anticipated combinations of failures within traditional turbojet engine control systems result in losing the normal means to control thrust (i.e., control via the throttle lever, autothrottle, etc.). A subset of the resulting failure conditions may include actual thrust either increasing to higher than commanded and/or remaining high when low thrust is commanded. These “Uncontrollable High Thrust Failure Conditions,” and the hazards they pose, have long been inherent in transport airplane designs. In fact, the “fail-safe” states for engine controls have traditionally been chosen to protect high thrust capability and allow the flightcrew to decide when an engine shutdown is appropriate.

An initial estimate indicates that over the last 20 years the average rate of occurrence for the uncontrollable high thrust failure condition on turbofan-powered large transport category airplanes has remained relatively constant at around one every 2.5 million flight hours. This would indicate that to date an “Uncontrollable High Thrust Failure Condition” has occurred hundreds of times without resulting in a single reported serious injury.

When these failure conditions were identified during past certifications, compliance was typically based on accepting an assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust, including shutting down the affected engine via an independent fuel shutoff as required. However, recent engineering studies and service experience, including a 1997 Saudi Arabian Airlines Boeing 737-200 accident, indicate this traditionally accepted assertion is not always valid. For those airplanes re-evaluated to date, the available failure recognition and accommodation time under certain anticipated operating conditions is so short and the required corrective actions sufficiently unnatural that the flightcrew cannot be relied upon to reliably and completely perform those actions before the safe operation of the airplane is jeopardized.

The FAA is responding to this revelation by developing a “Thrust Control Malfunction Airworthiness Program” to consistently and objectively assess and manage the existing and future transport airplane fleet risks associated with this endemic potential for non-compliance and unsafe conditions. The ultimate goals of this program will be to bring the transport airplane fleet back into compliance as quickly as practicable, while assuring the risks associated with interim non-compliances are managed so that they do not represent unsafe conditions.

In the interim, for type certification the FAA has begun requesting more effective validation of any assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust. Such a request is what led to the subject petition and is likely to lead to many more such petitions until practicable design solutions can be identified, validated, and safely integrated into turbine engine control system type designs.

#### Airbus Model A340-500/-600 & RR Trent 500 Series Engines

The engine thrust control system for the RR Trent 500 engine family proposed to be installed on the A340-500/-600 includes Thrust Control Malfunction (TMC) protection logic to mitigate uncontrollable high thrust conditions on the ground only. However, the petitioner has indicated that there are single failures in flight that can cause a RR Trent 500 series engine to produce high thrust, up to the level where the first independent limiter (governor) is encountered, while not responding to the throttle lever. Further, the petitioner has indicated that this may jeopardize the safe operation of the Airbus A340-500/-600 airplane if it occurs during some particular final approach phase conditions.

The petitioner intends to demonstrate that any combinations of failures that could jeopardize safe operation comply with § 25.901(c) in that they are not “probable combinations.” (Note: the term “probable,” as used in § 25.901(c), means “foreseeable,” “anticipated to occur,” or “not extremely improbable” and hence has a

very different meaning than the same term as subsequently used in association with § 25.1309(b) compliance.) Conversely, the petitioner does not intend to demonstrate that those single failures which could jeopardize safe operation comply with § 25.901(c). Compliance with § 25.901(c) requires each identified single failure be assumed to occur under all anticipated combinations of airplane operating and environmental conditions. While the single failures themselves must be assumed to occur regardless of their probability, probability can be considered when determining what combinations of operating and environmental conditions are anticipated to occur in the fleet life of the airplane type. Single failures do not need to be assumed to occur under conditions that are in and of themselves not expected to occur. Nonetheless, the proposed design is known to have single failures that will cause uncontrollable high thrust.

Uncontrollable high thrust under certain anticipated takeoff and landing conditions is expected to jeopardize the safe operation of the proposed airplane. Consequently, in order to certify the installation of the RR Trent 500 series engines on the Airbus A340-500/-600 airplanes, the petitioner must either obtain this exemption or substantially modify the associated engine control system design to mitigate the noted failure conditions in flight as well. As delineated in the petitioners supporting information, the petitioner has concluded that the exemption is the option which best serves the public interest.

#### FAA Analysis - Introduction

To obtain this exemption, the petitioner must show, as required by § 11.81(d), that granting the request is in the public interest, and, as required by § 11.81(e), that the exemption will not adversely affect safety, or that a level of safety will be provided that is equal to that provided by the rules from which the exemption is sought.

#### FAA Analysis - Public Interest

The petitioner has committed to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from § 25.901(c) for the A340-500 and -600/RR Trent 500 Series Engines. Airbus has indicated it intends to implement the Thrust Control Malfunction (TCM) logic on the A340-500 and -600 models equipped with RR Trent 500 series engines to ensure that compliance with FAR 25.901(c) “single failure” criterion is met for all ground uncontrollable high thrust failure conditions. If the FAA is to certify the Airbus A340-500 and -600/RR Trent 500 airplanes, making this commitment a condition of the exemption assures that granting the exemption will prove to be in the public interest. That is, any risks associated with a known non-compliance must be eliminated or further reduced wherever the FAA finds that to do so is technologically feasible and cost beneficial for the public. This has traditionally been accepted as the level of safety which is “in the public interest.” Furthermore, if bringing the airplane

into compliance is found to be a “practicable action,” then this exemption would in effect be self eliminating.

In consideration of the above, the FAA concludes that granting this petition is in the public interest.

#### FAA Analysis - Effect on Safety

The petitioner has committed to demonstrate that the A340-500 and -600/RR Trent 500 exposures and failure rates are such that this airplane should not exceed the known average per flight hour risks of comparable existing transport category airplanes. Making this commitment a condition of this exemption, in combination with the condition to minimize that risk, means that granting this exemption should not adversely affect and, in fact, should improve the average per flight hour risk within the current transport airplane fleet.

For those existing transport airplanes re-evaluated to date, the conditions under which an uncontrollable high thrust failure may jeopardize the safe operation of the airplane are limited to specific aborted takeoff or approach and landing scenarios. Given that these scenarios occur, there is still a low probability that any serious injury will result. This limited exposure, in conjunction with the historically low occurrence rates, make this a relatively low per flight hour risk. This assessment is supported by the fact that the 1997 Saudi Arabian Airlines Boeing 737-200 accident is the only one attributed to these types of failures and there were no serious injuries in that accident.

It is the spectre of this low per flight hour risk accumulating indefinitely on many, if not most, existing and future transport airplanes that is the primary concern driving development of the FAA “Thrust Control Malfunction Airworthiness Program.” To date, corrective actions under 14 CFR part 39 have only been deemed warranted when the uncorrected risks for a particular type design were considered significantly greater than the known average risks within the transport fleet. Since the conditions and limitations of this exemption require that the Airbus Model A340-500 and -600/RR Trent 500 be expected to have an uncontrollable high thrust failure rate over three times better than the current fleet average, the impact of adding the A340-500 and -600/RR Trent 500 fleet hours to the overall transport fleet exposure should be insignificant. Furthermore, if as part of the “Thrust Control Malfunction Airworthiness Program” the FAA determines that additional generally applicable precautions must be taken, including perhaps some future introduction of a compliant design, these will further minimize any cumulative risk impact of granting this exemption.

This exemption inherently implies a somewhat greater hazard than full compliance with § 25.901(c). This is why the FAA intends to bring the transport fleet back into full compliance as soon as practicable. Nevertheless, the fact that the per flight hour

risks associated with this non-compliance are low allows us to develop a well considered recovery program to assure we don't introduce a worse problem than we are trying to solve and that this recovery program is clearly in the public interest.

In consideration of the above, the FAA concludes that granting this petition will not adversely affect safety.

### **The Grant of Exemption**

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, Airbus is granted an exemption from § 25.901(c) to the extent necessary to allow type certification of the Airbus Model A340-500 and -600 airplanes with Rolls-Royce Trent 500 series engines without an exact showing of compliance with the requirements of § 25.901(c) as they relate to single failures resulting in uncontrollable high thrust conditions. For the Model A340-500 and -600, this exemption is subject to the following conditions and limitations:

1. Airbus must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that all practicable actions have been taken to minimize the adverse effects on safety associated with granting this petition. These must include, but are not limited to, practical actions to eliminate or further reduce the risks by improving designs, procedures, training, and instructions for continued airworthiness. Based on the proposed incorporation of the TCM logic to ensure compliance with § 25.901(c) for all failure conditions on the ground, Airbus must therefore demonstrate that extending the existing TCM protection to eliminate the inflight failure conditions during the final approach phase would either: (a) require a substantial modification, or (b) result in an overall net increase in “risk” due to the increased risk of multiple inflight shutdowns (IFSD).
2. Airbus must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that the risks associated with exempting the “uncontrollable high thrust failure condition” from the single failure provisions of § 25.901(c) are no greater for the proposed A340-500 and -600/RR Trent 500 model(s) than those generally known to exist for comparable airplanes within the current transport fleet. Acceptable risk for this provision can be characterized as:
  - a. The airplane complies with § 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and

- b. The expected frequency of occurrence of the uncontrollable high thrust failure condition is less than once per ten million airplane operating hours.
3. The following “Note” will be added to the airplane Type Certification Data Sheet for any airplane certificated under this exemption:

**The FAA has concluded that the occurrence of any uncontrollable high thrust failure condition, or any of the associated causal failures listed within Airbus Document [reference tbd], “may endanger the safe operation of an airplane” and hence are reportable under §§ 121.703(c), 125.409(c), and 135.415(c).**

In support of this “Note,” Airbus must develop and obtain FAA approval of the Airbus document referenced in the “Note,” prior to customer delivery. This document lists those failures that can contribute to or cause an uncontrollable high thrust failure condition covered by this exemption. This document shall then be made available as part of the instructions for continued airworthiness. Further, the failures listed within this document shall be added to the list of reportables under § 21.3 for any airplane certificated under this exemption.

4. The granting of this exemption does not relieve any regulatory obligation to identify and correct unsafe conditions related to uncontrollable high thrust failure conditions.

Note: Additional background and guidance regarding these provisions is provided in an e-mail message from the FAA to Airbus dated April 7, 2002.

Issued in Renton Washington on July 19, 2002.

/s/ Ali Bahrami  
Acting Manager, Transport Airplane Directorate  
Aircraft Certification Service